

CLAIMS

We claim:

1. A method of repairing an endosseous implant, including an implant base having an implant base axis, an abutment post joined to the implant base, and a tooth prosthesis joined to the abutment post, the method comprising:
 - removing the tooth prosthesis;
 - removing the abutment post;
 - resecting gingiva to expose tissue near the implant base;
 - cutting away tissue appropriate to create a desired recess by rotating a bone graft profiler tool around an axis which is at least approximately the implant base axis; and
 - installing, in the recess, a filler suitable to substantially fill the recess.
2. The method of claim 1, wherein the step of cutting away tissue includes a bone graft profiler tool having at least one dimension which is selected based on a dimension of the implant base.
3. The method of claim 1, wherein the step of cutting away tissue includes a bone graft profiler tool having at least one dimension that is selected based on characteristics of a particular site in a particular patient.
4. The method of claim 3, wherein the characteristics are determined by radiography in advance of surgery.
5. The method of claim 1, wherein the cutting away comprises locating the bone graft profiler tool with respect to the implant base.

6. The method of claim 1, wherein the cutting away comprises inserting into the implant base an alignment post, and wherein the cutting comprises locating the bone graft profiler tool with respect to the alignment post.

7. The method of claim 1, wherein the cutting away comprises orienting the bone graft profiler tool with respect to the implant base.

8. The method of claim 1, wherein the cutting away comprises inserting into the implant base an alignment post, and wherein the cutting comprises orienting the bone graft profiler tool with respect to the alignment post.

9. The method of claim 1, wherein the cutting away comprises limiting a depth of cut by contact of a portion of the bone graft profiler tool with the implant base.

10. The method of claim 1, wherein the cutting away comprises inserting into the implant base an alignment post, and wherein the cutting away comprises limiting a depth of cut by contact of a portion of the bone graft profiler tool with a top of the alignment post.

11. The method of claim 1, wherein the cutting away comprises using more than one bone graft profiler tool in succession.

12. The method of claim 1, wherein the cutting away comprises using the bone graft profiler tool followed by using a localized cutting tool.

13. The method of claim 1, further comprising, after the cutting away, applying antiseptic and/or antibiotic.

14. The method of claim 1, further comprising, after installing the bone graft, applying a surgical membrane.

15. The method of claim 1, further comprising, after all other steps, installing an abutment post which may be the abutment post removed earlier; installing a tooth prosthesis which may be the tooth prosthesis removed earlier; and putting the resected gingiva back in place.

16. The method of claim 1, wherein the filler is a formable material.

17. The method of claim 1, wherein the filler is a bone graft comprising a rigid material.

18. The method of claim 17, wherein the filler comprises synthetic material.

19. The method of claim 17, wherein the filler comprises demineralized bone matrix.

20. The method of claim 17, further comprising, after the cutting away, applying a formable filler material between the bone graft and the recess.

21. The method of claim 17, further comprising, after installing the bone graft, attaching the bone graft.

22. The method of claim 17, wherein the bone graft has at least one dimension which is selected based on characteristics of a particular site in a particular patient.

23. The method of claim 17, wherein the bone graft has at least one dimension which is selected based on a dimension of the implant base.

24. The method of claim 17, wherein the bone graft profiler tool has at least one dimension which is selected based on a dimension of the bone graft.

25. A method of repairing an endosseous implant which comprises an implant base, an abutment post joined to the implant base, and a tooth prosthesis joined to the abutment post, the method comprising: removing the tooth prosthesis; removing the abutment post; resecting gingiva to expose the implant base and bone or tissue near the implant base; cutting away tissue appropriate to create a desired recess; and installing, in the recess, a pre-formed bone graft comprising synthetic material or demineralized bone matrix.

26. The method of claim 25, wherein the bone graft is dimensioned to patient-specific dimensions prior to surgery.

27. The method of claim 25, wherein the cutting away comprises using a bone graft profiler tool.

28. The method of claim 25, wherein the cutting away comprises using a localized cutting tool.

29. The method of claim 25, wherein the cutting away comprises using a bone graft profiler tool followed by using a localized cutting tool.

30. The method of claim 25, further comprising, after the cutting away, applying antiseptic and/or antibiotic.

31. The method of claim 25, further comprising, after installing the bone graft, attaching the bone graft.

32. The method of claim 25, further comprising, after installing the bone graft, applying a surgical membrane.

33. The method of claim 25, further comprising, installing an abutment post which may be the abutment post removed earlier; installing a tooth prosthesis which may be the tooth prosthesis removed earlier; and putting the resected gingiva back in place.

34. A bone graft profiler tool comprising: a body which is substantially axisymmetric around an axis of symmetry; and, connected to the body, a gripped end suitable to be gripped by a rotary drive; and connected to or integral with the body, cutting features, wherein the bone graft profiler tool is able to rotate around the axis of symmetry and wherein the body and the cutting features are dimensioned suitably to create a desired axisymmetrically-shaped recess around an implant base.

35. The bone graft profiler tool of claim 34, wherein the cutting features are part of a connected structure which extends around a complete circumference.

36. The bone graft profiler tool of claim 35, wherein the connected structure defines an interior recess in the body, the interior recess being substantially cylindrical having symmetry around the axis of symmetry and being dimensioned suitably to accept a portion of an implant base.

37. The bone graft profiler tool of claim 35, wherein each cutting feature has a peak which is farthest from the body of the bone graft profiler tool, and wherein

the peaks all lie on a surface of revolution which is centered on the axis of symmetry of the bone graft profiler tool.

38. The bone graft profiler tool of claim 35, wherein the cutting features repeat in a periodic pattern an integer number of times in a circumference of the bone graft profiler tool.

39. The bone graft profiler tool of claim 35, wherein the cutting features are flutes, teeth, ridges or bumps.

40. The bone graft profiler tool of claim 34, wherein the cutting features are not part of a connected structure which makes a complete circumference.

41. The bone graft profiler tool of claim 40, wherein the cutting features are part of individual blades.

42. The bone graft profiler tool of claim 40, wherein the individual blades are spaced equidistantly from each other around a circumference of the body.

43. The bone graft profiler tool of claim 42, wherein the number of blades is two or three or four.

44. The bone graft profiler tool of claim 34 wherein the body and the cutting features define an external surface of revolution centered on the axis of symmetry, and the body and cutting features are dimensioned based on characteristics of a particular site in a particular patient.

45. The bone graft profiler tool of claim 44, wherein the characteristics of a particular site in a particular patient are determined radiographically.

46. The bone graft profiler tool of claim 34, wherein the bone graft profiler tool internal recess has a bone graft profiler tool internal recess inside diameter which is larger than an outside diameter of the implant base by between approximately 0.2 mm to 0.5 mm.

47. The bone graft profiler tool of claim 34, wherein no stop is provided within an anticipated range of depth of cutting.

48. The bone graft profiler tool of claim 34, wherein the bone graft profiler tool internal recess comprises a bone graft profiler tool internal recess roof.

49. The bone graft profiler tool of claim 48, wherein the internal recess roof can contact a top of the implant base to limit an advancement distance of the bone graft profiler tool.

50. The bone graft profiler tool of claim 34, further comprising an alignment post internal recess which continues from the bone graft profiler tool internal recess, the alignment post internal recess being substantially cylindrical having symmetry around the axis of symmetry and being dimensioned suitably to accept a portion of an alignment post.

51. The bone graft profiler tool of claim 50, wherein the alignment post internal recess comprises an alignment post internal recess roof.

52. The bone graft profiler tool of claim 51, wherein the alignment post internal recess roof is in a radial plane.

53. The bone graft profiler tool of claim 51, wherein the alignment post internal recess roof is part of a cone.

54. The bone graft profiler tool of claim 51, wherein the alignment post internal recess roof can contact a top of an alignment post to limit an advancement distance of the bone graft profiler tool.

55. The bone graft profiler tool of claim 54, wherein the alignment post internal recess roof can contact a top of the alignment post without the roof of the bone graft profiler tool internal recess touching a top of the implant base.

56. The bone graft profiler tool of claim 50, wherein the bone graft profiler tool internal recess roof can contact a top of the implant base without the alignment post internal recess roof contacting a top of the alignment post.

57. The bone graft profiler tool of claim 50, wherein an alignment post clearance is defined as an alignment post internal recess inside diameter minus an outside diameter of a cylindrical portion of a distal region of the alignment post, and the alignment post clearance is less than 0.5 millimeters.

58. The bone graft profiler tool of claim 34, wherein an implant clearance is defined as a bone graft profiler tool internal recess inside diameter minus an implant base outside diameter, and an alignment post clearance is defined as an alignment post internal recess inside diameter minus an outside diameter of a cylindrical portion of a distal region of an alignment post, and the alignment post clearance is less than the implant clearance.

59. The bone graft profiler tool of claim 34, wherein an alignment post clearance is defined as an alignment post internal recess inside diameter minus an alignment post outside diameter, and the alignment post clearance is less than 0.5 millimeters.

60. The bone graft profiler tool of claim 50, further comprising a transition where the alignment post internal recess meets the bone graft profiler tool internal recess.

61. The bone graft profiler tool of claim 60, wherein the transition is a curved axisymmetric surface.

62. The bone graft profiler tool of claim 60, wherein the transition is a chamfer.

63. The bone graft profiler tool of claim 60, wherein the chamfer is suitable for guiding the bone graft profiler tool into engagement with an alignment post.

64. The bone graft profiler tool of claim 60, wherein an annular radial dimension of the bone graft profiler tool internal recess roof is less than a horizontal dimension of the alignment post chamfer.

65. The bone graft profiler tool of claim 62, wherein a bone graft profiler tool depth-to-end-of-chamfer is less than an alignment post height-to-chamfer.

66. The bone graft profiler tool of claim 34, wherein an alignment post height is greater than a depth of the alignment post internal recess.

67. The bone graft profiler tool of claim 34, wherein the bone graft profiler tool comprises a mark on its exterior surface.

68. The bone graft profiler tool of claim 67, wherein the bone graft profiler tool has a stop and wherein the mark is located at the same position along the

axis of the bone graft profiler tool as a top of the implant base when the bone graft profiler tool stop is against its intended contact point.

69. The bone graft profiler tool of claim 67, wherein the bone graft profiler tool has a bone graft profiler tool internal recess roof and wherein the mark is located at the same distance along the axis of the bone graft profiler tool as the bone graft profiler tool internal recess roof.

70. The bone graft profiler tool of claim 34, wherein the bone graft profiler tool comprises passageways suitable to deliver liquid.

71. The bone graft profiler tool of claim 34, wherein the bone graft profiler tool has a hardness sufficient to cut bone.

72. The bone graft profiler tool of claim 34, wherein the bone graft profiler tool is made of corrosion-resistant metal.

73. An alignment post comprising an engagement region which is disposed to engage an implant base having an implant base outside diameter, and a distal region, extending outward from the engagement region, which is coaxial with the engagement region and, for at least a part of its length, is cylindrical.

74. The alignment post of claim 73, wherein the distal region is dimensioned suitably to cooperate with a bone graft profiler tool to either locate the bone graft profiler tool or align the bone graft profiler tool or both.

75. The alignment post of claim 73, wherein the distal region has a cylindrical portion having an outside diameter which is less than the implant base outside diameter.

76. The alignment post of claim 73, wherein the distal region has a cylindrical portion having an outside diameter which is substantially equal to the implant base outside diameter.

77. The alignment post of claim 73, wherein the engagement region comprises threads.

78. The alignment post of claim 73, further comprising, on the distal region at its end farthest away from the engagement region, a transition which is coaxial with the distal region.

79. The alignment post of claim 78, wherein the transition is a chamfer or a curved axisymmetric surface.

80. The alignment post of claim 73, further comprising, on the distal region at its end farthest away from the engagement region, a flat end.

81. The alignment post of claim 73 wherein the flat end is suitable to cooperate with a bone graft cutting tool to limit the advancement of the bone graft cutting tool along the axis of symmetry of the bone graft cutting tool.

82. The alignment post of claim 73, further comprising, in the distal region at its end farthest from the alignment region, an alignment post gripping feature suitable to engage an alignment post tool for rotating the alignment post.

83. The alignment post of claim 82, wherein the alignment post gripping feature is on the axis of the alignment post.

84. The alignment post of claim 82, wherein the alignment post gripping feature is a hexagonal recess or a spline recess or a hexagonal protrusion or a spline protrusion.

85. The alignment post of claim 73, further comprising, on the distal region at its end farthest away from the engagement region, a chamfer which is coaxial with the distal region.

86. The alignment post of claim 85, wherein the chamfer is suitable for guiding a bone graft profiler tool into engagement with the alignment post.

87. The alignment post of claim 86, wherein the bone graft profiler tool also comprises a chamfer.

88. The alignment post of claim 73, further comprising a shoulder suitable to abut against the implant base.

89. The alignment post of claim 88, wherein the shoulder is at a junction between the engagement region and the distal region.

90. The alignment post of claim 88, further comprising, at the shoulder, an undercut suitable to avoid interference with the implant base.

91. The alignment post of claim 73, wherein the alignment post is made of a biocompatible material.

92. The alignment post of claim 73, wherein the alignment post is sterile.

93. A bone graft suitable to fill a recess around an implant base, wherein the bone graft comprises rigid porous synthetic material.

94. The bone graft of claim 93, wherein the bone graft is pre-formed to a desired shape.

95. The bone graft of claim 93, wherein the bone graft comprises at least two separate pieces which together provide a desired shape.

96. The bone graft of claim 93, wherein the bone graft comprises a central hole.

97. The bone graft of claim 93, wherein the bone graft comprises a central hole having a bone graft inside diameter, and the implant base has an implant base greatest outside diameter, and the bone graft inside diameter is larger than the implant base greatest outside diameter by less than about 0.5 mm.

98. The bone graft of claim 93, wherein the bone graft is substantially axisymmetric.

99. The bone graft of claim 93, wherein the bone graft is non-axisymmetric.

330. The bone graft of claim 93, wherein the implant has external shape and dimensions which are chosen based on the shape and dimensions of a region of deteriorated or resorbed bone at a particular site in a particular patient.

101. The bone graft of claim 330, wherein the dimensions of the region of deteriorated or resorbed bone are determined radiographically.

102. The bone graft of claim 93, wherein the bone graft comprises a matrix of particles joined to each other forming a three-dimensionally interconnected network.

103. The bone graft of claim 102, wherein the matrix has pores wherein the distribution of pore volume as a function of pore size has a mode between 10 micrometers and 25 micrometers.

104. The bone graft of claim 102, wherein the matrix has a porosity between approximately 0.2 and approximately 0.6.

105. The bone graft of claim 93, wherein the bone graft comprises nonresorbable material.

106. The bone graft of claim 93, wherein the bone graft comprises hydroxyapatite.

107. The bone graft of claim 93, wherein the bone graft comprises resorbable material.

108. The bone graft of claim 93, wherein the bone graft comprises both nonresorbable and resorbable substances.

109. The bone graft of claim 93, further comprising channels which go into an interior.

310. The bone graft of claim 93, further comprising channels or patterns on a surface.

111. The bone graft of claim 93, wherein the bone graft comprises a surface having a surface geometry which is different from a geometry at an interior.

112. The bone graft of claim 93, wherein the bone graft comprises a surface having a surface composition which is different from a composition at an interior.

113. The bone graft of claim 93, wherein the bone graft comprises a surface having a surface geometry suitable to face natural bone.

114. The bone graft of claim 93, wherein the bone graft comprises a surface having a surface composition suitable to face natural bone.

115. The bone graft of claim 93, further comprising osteoconductive or osteoinductive substances.

116. The bone graft of claim 93, further comprising substances from a patient's own blood or other biological substances or demineralized bone matrix.

117. The bone graft of claim 93, further comprising a polymer.

118. The bone graft of claim 117, wherein the polymer is a comb polymer.

119. The bone graft of claim 117, wherein the polymer is resorbable.

120. The bone graft of claim 117, wherein the polymer is non-resorbable.

121. The bone graft of claim 93, wherein the bone graft is sterile.

122. The bone graft of claim 93, wherein the bone graft is manufactured at least in part by three dimensional printing.

123. A method of manufacturing a bone graft for filling a recess around an implant base, comprising spreading successive layers of a powder and three dimensionally printing an article to at least approximately the dimensions of the recess around the implant base.

124. The method of claim 123, wherein the powder comprises ceramic.

125. The method of claim 124, further comprising, after the three dimensional printing, heating the article sufficiently to partially sinter it.

126. The method of claim 123, wherein the powder comprises demineralized bone matrix.

127. The method of claim 123, further comprising, after all the described steps, introducing an additional substance into pores of the bone graft.

128. The method of claim 123, wherein the additional substance comprises substances from the patient's own blood or other biological substances.

129. An article manufactured by the method of claim 123.

130. A carrier having dimensions suitable to grip a bone graft which fills a recess around an implant base.

131. The carrier of claim 130, wherein the carrier comprises resilient material.

132. The carrier of claim 130, wherein the carrier comprises a spring or deformable member.

133. The carrier of claim 130, wherein the carrier is sterile.

134. A kit for installing a bone graft around an implant base, comprising: at least one bone graft having bone graft dimensions, and at least one bone graft profiler tool having bone graft profiler tool dimensions.

135. The kit of claim 134, wherein at least one bone graft dimension is coordinated with dimensions of the implant base.

136. The kit of claim 134, wherein at least one bone graft dimension is coordinated with characteristics of a particular site in a particular patient.

137. The kit of claim 134, wherein at least one bone graft profiler tool dimension is coordinated with dimensions of the implant base.

138. The kit of claim 134, wherein at least one bone graft profiler tool dimension is coordinated with characteristics of a particular site in a particular patient.

139. The kit of claim 134, wherein at least one bone graft dimension is coordinated with a bone graft profiler tool dimension.

340. The kit of claim 134, wherein the bone graft comprises synthetic material.

141. The kit of claim 134, wherein the kit comprises a plurality of bone graft profiler tools intended to be used in a specified sequence.

142. The kit of claim 134, wherein the kit comprises a plurality of bone graft profiler tools intended to be used independently of each other.

143. The kit of claim 134, wherein the kit comprises at least one tool for performing localized cutting.

144. The kit of claim 134, further comprising an alignment post.

145. The kit of claim 144, further comprising an alignment post installation tool suitable for engaging the alignment post.

146. The kit of claim 134, further comprising at least one additional article selected from the group consisting of: a carrier for gripping the bone graft, templates, surgical screws, tools for installing surgical screws, formable filler material, antiseptics, antibiotics, a surgical membrane, and sutures.

147. The kit of claim 134, wherein at least some articles in the kit are sterile.

148. A bone graft shaped to fit around an implant base and having a bone graft external surface, and a bone graft profiler tool having a cutting envelope, wherein the bone graft external surface and the cutting envelope relate to each other by a defined mechanical interference that is everywhere constant to within a tolerance of less than 0.4 mm.